SCIENCE:

A WEEKLY JOURNAL OF SCIENTIFIC PROGRESS.

NEW YORK, JULY 3, 1880.

THE UNITED STATES NAVAL OBSERVATORY, WASHINGTON.

BY PROFESSOR EDWARD S. HOLDEN.

This institution has been long and favorably known to the scientific public, not only of the United States, but of the whole world. It was founded in 1844, and commenced its operations in 1845, and as it is now about to enter a new epoch of its existence by a removal to a new and better site in the District of Columbia, a brief account of its progress will not be without interest.

Astronomy did not flourish in America during the eighteenth century. A few observations were made by Professors at Harvard and Yale Colleges, and in Pennsylvania by RITTENHOUSE and others (in 1769). A telescope was mounted in 1830 at Yale College for regular astronomical observations, and the first observatory was built at Williams College in 1836, by Prof. HOPKINS. Mr. WILLIAM C. BOND, of Dorchester, a maker of chronometers, had erected a small observatory at his residence, and this was afterwards removed and formed the nucleus of the observatory of Harvard College. The observatories of Hudson, Ohio, (founded 1837), of the Philadelphia High School (1840), of West Point Military Academy (1841), of Cincinnatti (1843), of Georgetown, D. C., (1844), and the Naval Observatory (1842), were the first established, and these observatories all erected within the decade, 1835-1845, were the signs of a growing sense of the importance of astronomical research among the people.

Probably due credit has not been generally given to the efforts of General O. M. MITCHEL the astronomer of the Cincinnati Observatory, who, by lectures, treatises and personal influence, kept the subject before the reading public. In Congress a few intelligent men, like Mr. JOHN QUINCY ADAMS, had always advocated the establishment of an observatory which should be truly national, but great opposition to such an institution was constantly displayed, and so late as 1832 a bill appropriating money for the survey of the coast, contained the clause "provided that nothing in this act should be construed to authorize the construction or maintainance of a permanent astronomical observatory."

The final establishment of the Naval observatory came about in this wise, and it was due largely to the admirable abilities of Lieutenant GILLISS, of the Navy.

The exploring expedition of Admiral WILKES (1838-1842), proposed making astronomical observations in all parts of the world, and to utilize these, corresponding observations were required at home. These were made by GILLISS in a small observatory on Capitol Hill for the four years and they were of high excellence. The present observatory building was erected as a "depôt of charts and instruments" for the Navy from designs by GILLISS. The regulations of the Service required that GILLISS should be sent to sea, and the direction of the observatory was confided to Lieutenant MAURY, who retained it till 1861. A corps of astronomers was formed and a detail made of the officers from the line of the Navy to care for the chronometers, charts and instruments, and to collect hydrographical information, and this plan of organization continued till 1866, when the Hydrographic office was separated from the Observatory. Suitable instruments were provided and the observations were published in quarto volumes, twenty-two of which have appeared up to 1880. The main instruments were:

1. A Transit Instrument (by ERTEL, of Munich).
2. A Mural Circle (by SIMMS, of England).
3. A Meridian Circle (by ERTEL).
4. A Prime Vertical Transit (by PISTOR & MARTIUS, of Berlin).
5. An Equatorial (by MERZ, of Munich), with an Object Glass of 9.62 inches.

These instruments were kept steadily at work and thousands of observations were made and have been reduced and published. The mere index to these ob-

servations fills 74 quarto pages. Certain special publications deserve particular mention. A catalogue of 10,658 stars, observed with the instruments 1, 2, 3, and 4, has been made by Professor YARNALL. It may be said to have been his life work, as he made a large share of the observations and reduced all of them. This catalogue is of great usefulness.

The Wind and Current Charts of MAURY, which have been adopted the whole world over, were constructed from observations collected and discussed here. With the equatorial, three asteroids were discovered by Professor FERGUSON, and Professor HALL and himself observed a great number of comets and minor planets. The theoretical researches of Professor WALKER on *Neptune*, of Professor HUBBARD on comets, and the work of Professors COFFIN and HUBBARD on points of practical astronomy, all belong to this first epoch.

The second stage of the Observatory's life may be said to have begun in 1861, with the superintendence of GILLISS, and to have extended to the present time under the direction of Rear Admirals DAVIS, SANDS and RODGERS. Two new first-class instruments were purchased.

6. The Transit Circle (1865), made by PISTOR & MARTINS.

7. The 26-inch Equatorial (1873) made by ALVAN CLARK & SONS. Both have been kept in constant use. With the first, the sun, moon, major and minor planets have been constantly observed and the materials for a very large and important catalogue of stars (soon to be published) have been collected. The telegraphic longitudes of many points in the United States and elsewhere, have been determined by Professors HARKNESS and EASTMAN. We may mention among these the longitudes of Havana (Cuba), St. Louis, Detroit, Carlin and Austin (Nevada), Ogden (Utah), Bethlehem (Pa.), Princeton (N. J.), Cincinnati, Nashville, Columbus, Harrisburg, and others. The large equatorial, besides making a great number of observations of double stars (HALL and NEWCOMB), and of Nebulæ (HOLDEN), has been employed on the observations of the faint satellites for which it is better fitted than any other instrument existing. The masses of *Uranus* and *Neptune* have been determined by Professor NEWCOMB and the capital discovery of two satellites to *Mars* made by Professor HALL.

The theoretical researches of Professor NEWCOMB on the Lunar Theory and on Fundamental Stars, and of Professors NEWCOMB and HALL on Satellites, belong to this period.

The Transits of *Venus* (1874), and of *Mercury* (1878), have been most thoroughly observed and discussed by the various astronomers.

The solar eclipses of 1869, 1870, 1878 and 1880 have been also elaborately observed by parties sent from the observatory, and the results are all published except those for 1878 and 1880, which will shortly appear. The work done here on solar eclipses alone is of the first importance, and will greatly forward our knowledge of solar physics. There is no space to mention the miscellaneous work done: the chronometers of the Navy, the furnishing of standard time to the United States, the observations of meteors, all receive their share of attention.

The third epoch of the history of the Observatory commences with the effort to change its site to one less exposed to the sickly influences of the malaria which rises from the marshes surrounding the Observatory on the river side, and to one where the fogs from the same source will not seriously interfere with the complete use of the instruments. This subject has, since 1870, received more or less attention, but the first serious effort to change the site for these reasons was made in a report of the Superintendent in 1877.

"UNITED STATES NAVAL OBSERVATORY,
Washington, September 15, 1877.

"SIR: I found upon taking charge of the Observatory, that the malarious influences surrounding it were notorious, and that from May to about the middle of October the officers whose services were necessarily in the Observatory at night, paid the penalty in impaired health and in diminished efficiency. The fogs which arise from the river, driven by the prevailing winds, float above the instruments and lessen their usefulness.

* * * * * * *

For these reasons, I earnestly recommend that a suitable site, north of the city and inside the District of Columbia, be procured for a new Observatory.

The area allotted to this purpose need not necessarily be more than twenty-five or thirty acres in extent; but as much as this is needed, since, if surrounded by dwellings or factories, the smoke would obscure the clearness of vision, the traffic would shake the instruments, and some high structure, if placed upon the meridian near our instruments, might hide a useful part of the heavens.

The present Observatory is in a very dilapidated condition.

* * * * * * *

I have the honor to be, very respectfully,
Your Obedient Servant,
JOHN RODGERS,
Rear-Admiral Superintendent.

Hon. R. W. THOMPSON,
Secretary of the Navy, Washington.

The accompanying papers show that the death of two superintendents, Captain GILLISS and Admiral DAVIS, was either caused or accelerated by malarial fever, and that the death of Professors FERGUSON, SPRINGER and HUBBARD, could be traced directly to this cause. The prevalent fogs are shown to interfere with observations.

In short, this report brought prominently forward a fact which had always been patent, viz.: that it was almost a crime and certainly an extremely poor use of

the resources of the observatory, to continue its astronomers and its instruments in the present situation. A petition was presented to Congress (1878, Jan. 10), from prominent men of science, asking for its removal, and Jan. 16, 1878, a bill was introduced by Mr. SARGENT in the Senate, providing for the appointment of a commission to select a suitable site. In the mean time a plan for the new building had been prepared at the observatory, submitted to all the prominent astronomers of the country for their suggestions, corrected and adopted. The report of the Commission, consist, ing of Admiral AMMEN, U. S. N., Colonel BARNARD- U. S. A., and LEONARD WHITNEY, Esq., was made 1878, Dec. 7. It recommended the purchase of "Clifton," a beautiful site of 45 acres in Georgetown, situated on Rock Creek.

Unfortunately, it was not learned until after the report was made, that it had been seriously contemplated to build a railway down the valley of Rock Creek. This report was not acted on, owing to the fact that the presence of a railway would seriously interfere with the stability of the instruments. Therefore a new commission was appointed Feb. 9, 1880, consisting of Senator W. P. WHYTE, Representative L. MORSE, and Admiral RODGERS, U. S. N., under a bill approved Feb. 4, 1880, which appropriated $75,000 to the purchase and selection of a suitable site. The officers of the Observatory were directed to examine the many sites offered for sale. These lay in three different parts cf the city: first, north of the capital near the Soldiers' Home Park, and near the Baltimore & Ohio Railroad; second, north of the main part of the city; third, northwest of the city, in Georgetown. The preferences were for the sites in the first section. Each site that was at all eligible was tried in the following way: the fundamental observations depend upon the accurate measures of the zenith-distances of stars. As the zenith is not a visible point the nadir point (which can be made visible, and which is directly opposite the zenith point) is chosen. A box of quicksilver is placed immediately beneath the meridian instrument and the position of the reflected images of the spider lines of the instrument observed; when these coincide with the spider lines seen directly, the instrument is vertical or it is pointing to the nadir. Such observations as these have to be made at all hours of the night and day, and anything that seriously interferes with them will prevent the taking of satisfactory observations. The question then was, to try each of the proposed sites with this test and to unhesitatingly reject any site which did not fulfill the conditions. To do this a post was firmly planted in the ground. On the top of this a flat basin containing quicksilver was placed. A telescope was directed towards the quicksilver about dusk, so that the image of the pole star should be seen in the telescope. This image usually showed as a neat quiet round disk. The times of the passing of railway trains was known, and at these moments the image of the star was watched. For many of the places tried, the vibration of the mercury surface caused by the tremors of the ground was so great that no image of the star could be seen for many minutes during the passing of the trains. This was a fatal objection, since similar observations may have to be taken at any moment of the night or day.

For those places near a public road the experiment was varied by causing a loaded wagon to be driven rapidly up and down. The experiments were always made at least twice to avoid errors, and only those places rejected which were plainly unsuitable on this account. No matter what might be their other advantages, if they did not stand this test they were useless for astronomical purposes.

The places just north of the city were rejected on account of the smoke always rising from the mass of chimneys, an artificial and constant fog. In this way the choice has been narrowed down to two places. One directly south of the great park of the Soldiers' Home and one in Georgetown. The first is so situated that to make it suitable for observatory purposes a very large quantity of land would have to be bought; the second place can be bought with the appropriation. The matter is in this condition at present. No choice has been made by the commission as yet. There is, of course, a great desire on the part of landowners to force the commission to buy land in their neighborhood, but the choice must finally be made on the principles heretofore adopted. The new Observatory is to stand for a century at least and no small and petty personal considerations should be allowed to enter.

THE PRACTICAL VALUE OF SCIENCE.

"I have endeavored to state the higher and more abstract arguments by which the study of physical science may be shown to be indispensable to the complete training of the human mind, but I do not wish it to be supposed that because I may be devoted to more or less abstract and unpractical pursuits I am insensible to the weight which ought to be attached to that which has been said to be the English conception of Paradise—namely, 'getting on.' Now the value of a knowledge of physical science as a means of getting on, is indubitable. There are hardly any of our trades, except the merely huckstering ones, in which some knowledge of science may not be directly profitable to the pursuer of that occupation. An Industry attains higher stages of its development as its processes become more complicated and refined, and the sciences are dragged in, one by one, to take their share in the fray."—*Huxley*.

A BIT OF SUMMER WORK.

BY PROFESSOR BURT G. WILDER, M. D.

Notwithstanding the number of "Summer Schools of Science" to be in operation this season, many teachers are likely to pass the vacation at a distance from the facilities afforded by organized laboratories. How shall they employ their time?

Doubtless they all need rest, and in most cases at least a fortnight should elapse before any intellectual labor is undertaken. An equal period of repose may well occur just before the renewal of teaching in the Fall. But the teacher who hopes to make his instruction each year more thorough and successful than the last, will be pretty sure to spend the remaining month or two in the search of help from books, and, while regretting the vagueness of the information thus obtained, may seldom think of making it more real by personal observation.

Now it is true that in some branches of science this may require appliances not readily obtained. This is the case with Chemistry and Physics, and some parts of Natural History. But Botany and Entomology may be pursued under almost any circumstances, and I venture to suggest that at least one kind of *anatomical* work may be carried on with but a slight amount of apparatus.

Obviously, the summer is not the most favorable time for study of the viscera, while anatomical details respecting the muscles, vessels and nerves are not especially required for ordinary instruction. But the *brain* is not only the organ least satisfactorily treated in the text-books, but at the same time the one concerning which the most should be known, from the double standpoint of physiology and psychology.

But how can the teacher procure brains, and how shall he preserve them when obtained?

The question is a perfectly natural one in view of the prevailing impression that cerebral structure is to be learned from the human brain alone. So far from correct is this idea, that from a single animal brain, perfectly fresh or well preserved, more may be gained than the average medical student learns from the human brains usually examined in the dissecting-room.

This is due to the fact that, excepting the absence of the occipital lobes of the hemispheres, the brains of the cat, the dog, the rabbit and the sheep present nearly all of the structural features of the human brain, while their smaller size and greater accessibility better adapt them for manipulation and for the preservation of the numerous specimens which are needed to display all parts of the organ.

Of the animals above named the cat seems to be the most favorable subject. It is always and everywhere obtainable; the brain is larger than that of the rabbit, and more easily extracted than those of the sheep and most dogs.

Some features of the brain, as the coloration of different parts, and especially the relation of the gray and white substances, are better seen upon fresh specimens; but the beginner will do well to examine hardened brains first, so as to become familiar with the form and relative position of the parts, and with their names.

Among the instruments needed for the removal and dissection of the brain the most essential are a very sharp knife, and a pair of "wire-nippers" with the blades set at a slight angle with the handles. *

As an aid to the study of the brain any work upon Human Anatomy will be found useful. The best are those of "Quain" and "Gray." Descriptions, without figures, of the brains of the sheep, and of the dog and rabbit, are given in the little works of Morrell and Foster and Langley. With some modification these apply to the brain of the cat. †

Finally, it is hardly necessary to urge that outline drawings be made of the brain as a whole, and of its parts as exposed by dissection. If this is done, by the end of the summer the teacher will have become better able to appreciate the peculiarities of the human brain when one comes in his way, and will have laid a substantial foundation for the physiological and psychological instruction which he may be called upon to impart.

ANTIPATHARIA OF THE "BLACK" EXPEDITION.—In vol. iv. No. 4 of the *Bulletin* of the Museum of Comparative Zoology at Harvard College, Cambridge, Mass. (February), L. F. Pourtales describes twelve species of this interesting group taken in the Caribbean Sea (1878–79). In determining the species an attempt has been made to use the differences in the shape of the polyps, as well as the disposition and form of the spines to draw characters for a much-needed revision of their classification. It would seem as if there were at least two different types of spines: the triangular compressed and the more cylindrical. These latter are generally more densely set, even assuming sometimes a brush-like appearance, as in *Antipathes humilis*, a new and wonderfully spinous species, figured but not described by Pourtales. These cylindrical spines are also unequal on the two sides of the pinnules, being longer on the side occupied by the polyps, with a very few around the polyps. The triangular spines are disposed regularly in a quincuncial order around the pinnules, and in a cleaned specimen nothing indicates the place formerly occupied by the polyps. In one series, however, *A. desbonni*, the spines are in regular verticils. There would appear to be a connection between the shape of the polyps and the shape and disposition of the spines. Those species with triangular spines have polyps with longer tentacles than those with cylindrical spines, and the tentacles have a greater tendency to become regular in shape.

---

* These nippers are imported from Germany by H. Boker & Co., of New York, and are for sale by A. J. Wilkinson & Co., of Boston, and Treman, King & Co., of Ithaca, N. Y. They cost about 75 cents.

† Hektograph copies of instructions for the removal, preservation and dissection of the cat's brain may be had upon application to Mr. F. L. Kilborne, Anatomical Laboratory, Cornell University, Ithaca, N. Y.

ELECTRICITY AS POWER.

BY FRANCIS P. UPTON, ESQ.

In the early history of electrical science, many forms of engines were made, by which the power of electricity could be shown. Each was as wonderful as the other to the unthinking observer; for, without apparent combustion of fuel, work was done. We find, among the largest of these engines, one used in St. Petersburg, to drive a small boat, and one in this country to propel a train.

The United States Congress voted a sum of money to Prof. Page to carry on his experiments and he built a very efficient motor. After many experiments, though it was found that any amount of power could be obtained, yet the expense was so great as to make it of no practical value. In a small machine, the consumption of zinc might not be noticed, while in a large machine it would be found to burn exactly as the work was taken. Now that the doctrine of energy is clearly understood, the folly of the attempt can easily be seen. In a battery the fires are fed with an expensive metal. The energy developed by the zinc, thus used, was given to it artificially when it was reduced from the ore. In order to obtain a convenient fuel, both the coal and zinc ore must be mined, and the latter reduced, absorbing in the reduction a very small per cent. of the energy of the coal used in the process. Thus batteries for furnishing power consume a fuel at least fifty times more expensive than coal.

Besides the cost of fuel, the atmosphere, so to speak, in which the zinc burns, must be furnished to it artificially in the shape of acids or solutions. Though this has nothing to do with the theoretical cost, yet in practice, it is found to be the largest item of expense. It resembles furnishing a boiler with air made by a chemical process, so far as the economy of combustion is concerned. Yet the convenience and reliability of a battery to burn zinc has, where very small amounts of power are required, allowed of its use commercially, since steam is extremely difficult to manage in fractions of a horse power.

To-day the practice has been entirely reversed from what the first experimenters expected to realize. For electricity is now entirely made by means of steam engines to drive large motors. The last few years have brought the means of generating and using electrical currents to such a high state of perfection that power may be with economy transferred by them.

The loss in transferring is double; if a machine converts fifty per cent. of the power it receives from a staem engine, only fifty per cent. of that can be utilized, that is, twenty-five per cent of the original; thus wasting seventy-five parts out of each hundred of energy. A sixty per cent. machine can render effective thirty-six per cent.; an eighty per cent. machine can turn into useful work sixty-four per cent., and so on. This wasting of power in the transmission is more than counterbalanced in a great many cases by its delivery at the point where needed; for example, from a waterfall to a field for ploughing and threshing, as has been done in France; or from the shore to the water for the purpose of driving a torpedo boat, as has been done in this country.

Lately experiments have been made to show the application of electricity to railroads. Mr. Siemens, in Berlin, and Mr. Edison, at Menlo Park, are experimenting with electrical railroads. Mr. Edison uses the rails as conductors of electricity, the current going in one and returning in the other. The wheels are insulated, so that, by means of brushes on them, the electricity may be brought to the moter, which is on a carriage. The moter is simply one of Mr. Edison's generating machines, laid on its side, and connected by suitable mechanism to the axle of the driving wheels. On an experimental track of one-half mile length, a speed of twenty to thirty miles an hour has easily been reached, in spite of heavy grades and sharp curves.

For elevated and underground railroads, this method has many advantages; it does away with all the smoke and noise from the puffing of the locomotive, and substitutes for the many locomotives a few stationary engines scattered along the route. Mr. Edison feels very confident of success, since his troubles so far have all been in transferring the power from the armature to the driving wheels. He thinks that if the armature is only reliable, experiment will lead to proper mechanical devices for transferring the power from the quick-running armature to the slower driving wheels.

The road will be very useful in mountainous regions, since the engine is quite light and can be carried by trestle work and light earth work, over any country. The engine and boilers are not in this case put on wheels and required to push themselves over grades and around curves, but are placed in the valley below. Perhaps in many cases they may be done away with and water used to drive the generators.

For beach roads, in grand exhibitions, as feeders to main lines, and in many ways it is easy to see that use may be made of a properly constructed road. The gentle fluid, which has so quietly, for many years been the swift messenger of man, is now showing that it is also able to be a strong and lusty servant, and carry any load that it may be asked to take.

ELECTRICAL INSECTS.—It is not generally known that there are insects which possess the peculiar electrical properties of the Raia Torpedo and Gymnotus Electricus. Kirby and Spence, in their entomology, describe the *Reduvius Serratus*, commonly known in the West Indies by the name of the *wheel bug*, as an insect which can communicate an electric shock to the person whose flesh it touches. The late Major-General Davis of the Royal Artillery, well-known as a most accurate observer of nature, and an indefatigable collector of her treasures, as well as a most admirable painter of them, once informed me, that, when abroad, having taken up this animal and placed it upon his hand, it gave him a considerable shock, with its legs, as if from an electric jar, which he felt as high as his shoulder, and dropping the creature, he observed six marks upon his hand where the six feet had stood. Two similar instances of effects upon the human system resembling electric shocks, produced by insects, have been communicated to the Entomological Society by Mr. Yarrell; one mentioned in a letter from Lady de Grey, of Groby, in which the shock was caused by a beetle, one of the common *Elateridae*, and extended from the hand to the elbow on suddenly touching the insect; the other caused by a large hairy lepidopterous caterpiller, picked up in South America by Capt. Blakeney, R. N., who felt on touching it a sensation extending up his arm, similar to an electric shock, of such force that he lost the use of his arm for a time, and his life was even considered in danger by his medical attendant.

SCIENCE:

A WEEKLY RECORD OF SCIENTIFIC PROGRESS.

JOHN MICHELS, Editor.

PUBLISHED AT

229 BROADWAY, NEW YORK.

P. O. Box 3838.

SATURDAY, JULY 3, 1880.

To Correspondents.

All communications should be addressed to the Editor—Box 3838, P. O., New York—with name and address of writer, not necessarily for publication without consent.

Scientific papers and correspondence intended for publication, should be written *legibly* on one side only of the paper. Articles thus received will be returned when found unsuitable for the Journal.

Those engaged in Scientific Research are invited to make this Journal the medium of recording their work, and facilities will be extended to those desirous of publishing original communications possessing merit.

Proceedings of Scientific Societies will be recorded, but the abstracts furnished must be signed by the Secretaries.

Both questions and answers in "Notes and Queries" should be made as brief as possible; an answer appearing to demand an elaborate reply, may be written in the form of an article.

To Subscribers.

Terms of subscription for SCIENCE will be $4 a year, payable in advance. Six months, $2.50. Single copies 10 cents.

Subscriptions forwarded by mail should be addressed to the Editor, Box 3838, P. O., New York, and Post-office orders made payable to "John Michels."

To Advertisers.

Terms for advertising may be obtained at the office of Journal, 229 Broadway.

SALUTATORY.

In presenting to the public the first number of "SCIENCE," we would briefly define its aim and scope, so that its position in the periodical literature of the country may be clearly understood.

While Literature proper, and Art, both ornamental and useful, nay, almost every distinctive social and economic interest in the United States, have their several organs for the interchange of views or the diffusion of information, Science still remains without any weekly journal exclusively devoted to the chronicling of its progress, and the discussion of its problems.

This may be stated without disrespect to many excellent weekly journals restricted to special branches of science, or allied to trade interests.

The field being thus open, after consultation with many of the leading scientists in this country, it has been decided to publish "SCIENCE" in its present form. Its aim will be to afford scientific workers in the United States the opportunity of promptly recording the fruits of their researches, and facilities for communication between one another and the world, such as are now enjoyed by the scientific men of Europe.

A distinctive feature in the conduct of this Journal will be that each department of science will be supervised by some recognized authority in that field of research, and it is believed that the names of these Associate Editors will be a guarantee that accuracy be maintained so far as possible.

There will be a department of "*Notes and Queries*," which cannot fail to be of benefit to those engaged in original research. By this means many may attain the speedy solutions of difficulties which otherwise might cost them much unprofitable labor.

It is the desire of the Editor that "SCIENCE" may, in the United States, take the position which "*Nature*" so ably occupies in England, in presenting immediate information of scientific events; the Smithsonian Institution and other scientific bodies have promised their co-operation in this respect, and representative men in all branches of science have cordially volunteered their aid towards making "SCIENCE" as useful as its foreign contemporary.

We shall supply with each volume a comprehensive Index. The size of the journal is convenient for binding, and it should form a valuable work of reference in every library.

A short time must elapse before our arrangements, at home and abroad, can be completed, but we trust that this journal, even in its earliest stages, will be welcomed by all interested in scientific progress.

As one of its "Occasional Papers" the Boston Society of Natural History has published a volume of great value on the "Geology of Eastern Massachusetts," by W. O. Crosby. It is evidently the result of long and competent investigation, is well illustrated, and contains a large and well-printed geological map of the region treated of.

Interesting discoveries are reported from Italy. Near Este, in the Venito, at the foot of the Eugancian Mountains, Prof. Prosdocismi discovered a prehistoric burial ground with many bronze and clay vessels. Eighty-two tombs were found, of which forty-four seemed to have been opened already by the Romans, while the contents of the others seemed untouched. The urns belong to three different periods; some are stained black with linear ornaments; others are striped red and black. Some vases are of such exquisite workmanship that they could, even to-day, serve as patterns. A small case of bronze is adorned with human and animal figures.

A bronze statue of Leibnitz, measuring 3½ metres in height, is about to be erected at Leipzig, on the southern side of St. Thomas Churchyard. This memorial to the great German philosopher will be executed by Professor Hänel, of Dresden.

THE announcement is made that Dr. Carpenter the well known Microscopist, and author of one of the best works on the subject, will pay a visit to the United States during 1880. We can accord him the promise of a warm reception in this country, where he will be welcomed by all classes of Scientists, for his researches have covered a wide range of scientific investigations, which were recorded in language so felicitous, that he gave a charm even to the most abstruse subjects.

THE Twelfth and Thirteenth Annual Reports of American Archæology and Ethnology contain, as usual, several papers of great ethnological interest. From the Report of the Curator, Mr. F. W. Putnam, it is evident that much excellent work continues to be done in the museum, which is rapidly becoming one of the most valuable repertories of ethnology in the world. The papers are all connected with American ethnology, the most important probably being that of Mr. Baudelier, on the Social Organization and Mode of Government of the Ancient Mexicans.

ICHTHYOPHAGY is about to receive a new impetus by the organization of the Ichthyophagous club, the object of which is "to reveal to gourmets the unsuspected excellence of many neglected varieties of fish-food, and to make manifest to the people at large the still untried capacity of sea, lake, and river, to yield the materials of human nourishment." The first dinner of the Ichthyophagists will take place at the Rockaway Beach Hotel on the 30th instant, which though partially experimental, will include enough familiar components to satisfy the least adventurous taste.

The President of the club is John Foord, Esq., managing Editor of the New York Times, and Mr. E. G. Blackford, Treasurer, who will receive the names of those who desire to attend the dinner, and enroll themselves as Ichthyophagists.

DIATOMACEÆ *v.* DESMIDIACEÆ.

Dr. Jabez Hogg, the well-known professional microscopist and author of "The Microscope—Its History, Construction and Application," recently wrote a letter, in which he incidentally spoke of "Bacillaria paradoxa" as a desmid. On being challenged to give his reasons for such a classification, Dr. Hogg wrote the following letter:

BACILLARIA.

[17575].—Mr. Fedarb (17334) wishes to know my reasons for classing Bacillaria amongst Desmidiaceæ, and I beg him to understand that it is not my classification, but that of botanists who long ago claimed them; and as biologists have thought fit to acquiesce in this arrangement, I fear there is now no help for the microscopist; he must quietly submit. Ehrenberg, as many of your correspondents well know, placed them in his great family of Infusoria, but Kützing, and other naturalists, a few years ago, regarded Bacillaria paradoxa as a species of Algæ. In the last edition of Pritchard's "Infusoria," edited by men of repute, Bacillaria are placed in the family of Surirelleæ. The reason assigned for this is, that diatoms and desmids differ very little in their general characteristics. Both without much impropriety are said to be cellular plants inhabiting salt and fresh water. They certainly differ, inasmuch as diatoms have a dense silicious skeleton, usually divisible into two parts, or valves, and are without coloring matter or chromule. Desmids, on the other hand, have a non-silicious envelope, which is separable into two segments, and are filled with green coloring matter—chromule. The vital phenomena presented are nearly identical. Diatoms are more lively and have a more animal-like motion, and their silicious skeletons are almost indestructible, and their envelope is very transparent and of a gelatinous nature. Desmids, I believe, are destitute of the sarcode element, and are quite destroyed on being submitted to boiling. The movements of Bacillaria paradoxa are so remarkable, and so little understood, that in commenting upon them I was anxious to elicit the opinions of those whose opportunities for studying their habit were much greater than my own.

With reference to Mr. Fedarb's request, that I should specialize the "contaminating agents" of impure water, he will find that I have made some attempt to deal with this difficult question in the present number of the *English Mechanic*.

JABEZ HOGG.

At our request, Professor H. L. Smith, of Geneva, N. Y., who has made a special study of the Diatomaceæ, has written a comment on Dr. Hogg's explanation, which appears to effectually dispose of this matter.

NOTE.

It is really astonishing to see what errors one may fall into when writing upon a subject about which one is ignorant. "*Ne sutor ultra crepidam*," is a maxim which has not lost its force yet. The arguments, if one can call them so, adduced above for classing diatoms with dismids are easily disposed of. The author does not seem to be aware that the family name Bacillariæ (adopted in the early days of microscopical study, for what we now call Diatomaceæ) has long been dropped; the name was given from the then most striking genus, Bacillaria, of which one of the species is B. paradoxa. I am not aware that any respectable Botanist, or Biologist has ever claimed, as asserted in the above communication, that diatoms and desmids are to be classed together, except that both are algæ. If, for this reason, Bacillaria paradoxa can be called a desmid, we may call, *e.*, *g.*, since both are phænogams, Hepatica triloba a Honeysuckle· What is meant precisely by saying that the editors of Pritchard place Bacillaria in the family of Surirelleæ, or how it has any bearing on the question of calling it a desmid, is difficult to understand. Really the writer of the above note has very little comprehension of what he is driving at. No one knew better than Mr. Ralfs, editor of Pritchard, article diatoms, the distinctions between diatoms and desmids, and nowhere does he fail to keep them distinctly separate. It is not merely the silicious frustule, "skeleton" as it is called above, for many of the diatoms are not silicious, but it is their different structure, different internal substance, different modes of growth, that marks them as distinct; moreover desmids are not found, as is stated, in salt water, though diatoms are, and very abundantly too. In fine, not a single respectable writer, either in botany or biology can be cited, from Kützing down, who will call Bacillaria paradoxa a desmid. The question is not one of both being algæ; this every one now-a-days concedes; but it is as to the propriety of calling an acknowledged diatom (one that once gave the family name to this group of organisms,) a dismid.

H. L. SMITH.

IMPROVED THERMO-ELECTRIC APPARATUS.

At a meeting of the Physical Society on April 24, several papers were read by Mr. R. H. Ridout, F.C.S., including one on an Improved Thermo-electric Apparatus, of which the following is an abstract:—

Whilst most instruments of research have undergone a process of developments the beautiful instrument of Melloni does not appear to have progressed since the day of its inception. Much annoyance arises from the pile and galvanometer being separate, and it is a very common occurrence for a pile to be used with any galvanometer that comes first. In reality they are parts of one instrument, and should therefore be fixed to the same base-board. Treating them as parts of one whole, many defects are to be found in theory and construction, and also in the mode of using. I have made a critical examination of each part, and embodied the improvements in an instrument which, with the assistance of Mr. Browning, combines great delicacy and simplicity.

The defects in the theory of the pile are, that the essential or internal resistance must always be much less than the external resistance, and from the low tension of the current, the disparity cannot be wiped out by using a great length in the galvanometer. In practice the faults are,—(*a*), the junctions are too deep, and cause short circuiting; (*b*), the bars are too long and give unnecessary resistance; (*c*), they are too numerous; (*d*), the junctions are too slender; (*e*), the mass of matter to be heated is too great. These are remedied (*e*, *a*, and *d*) by placing the bars in glass tubes, connecting with them plates of copper; (*b*), bars made half usual length; (*c*), a single pair only is used.

The defects of the galvanometer are:—(*a*), the space nearest the needles is not utilized by the wire; (*b*), the needles are not of the best shape; (*c*), the suspension is troublesome. The remedies are:—(*a*), the wire is made into flat ribbon, and wound in one bobbin, and the needles mounted so as to permit this; (*b*), the needles are flat oblong plates, taken from the same piece of steel, and magnatized in one piece; an agate cup and pivot remedy (*c*).

In manipulation the faults are: (*a*), the several parts are not mutually adapted; (*b*), junctions by different metals are exposed; (*c*), the pile and galvanometer are connected first, when, in reality, they should not be connected till the pile has been exposed, or else the current generated abstracts the heat from the hot side, and lowers its temperature.

In the complete instrument, as made by Mr. Browning, the pile consists of a pair of elements ½in. long, the copper connections being circular plates 1-100in. thick, and ⅝in. diameter. The pile is supported by its thick copper terminals above the galvanometer, which consists of a flat copper ribbon, making about 20 turns round a pair of astatic needles, 1in. long, and ⅛in. broad, supported on an aluminium frame, and resting on a fine pivot by an agate cube. A contact key is placed at one side, and makes the only connection in the middle of the instrument. The whole is inclosed in a glass shade, having a perforation at the height of the face of the pile. A glass cone protects the front face from the extraneous heat, and a glass cap the back one. A directing magnet placed above the pile enables the readings to be taken in any position.

The source of heat being placed in front of the pile, the shade is turned round till the hole is in the axis of the pile, and left exposed for say 30 seconds. Contact is then made, when the deflection of the needle indicates the strength of the current very nearly. A very distinct deflection may be obtained from a person standing 6ft. from pile, and a common candle affects it at 3ft. Further, it shows that the walls of a room are of different temperatures, and in any clear weather radiation into stellar space is very evident. The whole thing can be put ready for experiment in half a minute, while, with other forms, the necessary adjustment usually takes more time than the experiments. The same form of galvanometer is also supplied separately.

ERRORS OF REFRACTION IN THE EYES OF MICROSCOPISTS.

BY JOHN C. MORGAN, M. D.

It will, I think, be at once admitted that the requirements in construction and adjustment of glasses, and the results of work done, must vary greatly with individualities of the workers' eyes.

One of the most important, but least thought of, is *astigmatism*,* a condition known to oculists as a common cause of occipito-cervical headaches, sometimes so severe as to be considered due to grave hyperæmia of the brain, or to "brain-fag," etc.

This defect consists in a diversity of curvature; hence, of refraction of one meridian of the cornea, as, for instance, the vertical, with another meridian (horizontal). One of these meridians may be "far-sighted," the other "near-sighted," or the difference may be more moderate.

Some slight degree of this is quite common, as many of your readers will discover on viewing a black line at a convenient distance in these and other positions. In one it will look black and sharp; in another, at a right angle, pale, ill defined, and as if the rays were cut off by a longitudinal slit in a diaphragm. Such a slit, turned in various positions, has a curious effect, illustrating the influence of loss of the rays. Astigmatism similarly affects vision; only, in this, dispersion is the immediate cause of loss.

Another and very simple test of astigmatism is "the point of light"—e. g., a gas flame, reduced to its smallest dimensions (of the yellow), when, to a normal eye, across a large room, it appears as a round point; but not so to astigmatic or to other abnormal eyes. Dispersion of rays results from imperfect focussing; and the object seems larger in consequence (but less bright). If this dispersion be only in one meridian of the eye (astigmatism), the apparent enlargement will be in *exactly the same position*, and the image will be long, not round, and thus the individual may note the precise angle in which a cylindroid lens must be worn, for "correction," and the restoration of the round image. If this meridian be short-sighted, the cylindroid must be concave; if far-sighted, convex.

The experiment may be varied by using a dark card, with a ⅛ inch round hole in it; when placed before a window, strongly illuminated, the point of light appears, of course, and it is more accurate in shape than the flame.

One point more. Spasm of the focussing apparatus (called "spasm of accomodation") may derange the sphericity of the eye, and so affect vision. *Strained* vision is liable to this. On the other hand, the same apparatus may be paralyzed, and *ordinary* vision deficient, whilst the focussing of the microscope entirely *corrects* it.

A linear marking, long or short, on a diatom, or a scale, or a cell, must suffer the same variation in divers positions after the passage of the rays through the best glasses. Some of the disputes as to these may be traced, doubtless, to this cause; and probably may be set at rest by the use of *astigmatic spectacles* with the microscope.

These are merely lenses of prescribed cylindrical curvature, whose axis is placed in the position of the abnormal corneal meridian, whereby its curvature is corrected. The general effect is to render the whole cornea practically spherical in form.

Astigmatism has been an injury to painters, as Turner, whose later pictures (the power of accommodation, or self-correction, being lost with age) are discovered to be distorted in consequence; the tendency being to exaggerate the size of the paler dimension in painting it.

On the contrary, in microscopic drawing, as with the camera lucida, the improperly pale line will be perpetuated, and the perspective misrepresented; and distortion of dimensions generally may be perpetrated by the most careful observers, and endless disputes may thus arise.—*American Journal of Microscopy.*

* From the Greek, *a*, *privative*, and stigma, *a point*—want of focal point.

ASTRONOMY.

Mr. Stone, F. R. S., the Radcliffe observer, has recently drawn the attention of astronomers to a most interesting system of stars in the Southern Hemisphere, which seems to present a remarkable case of an apparent connection between stars widely distant from one another.

Astronomers are familiar with cases of double stars, which seem connected together in some manner analogous to the Earth and Moon. But these stars are very close to one another,being only separated by a few seconds of arc. In the present case the stars form an isosceles triangle, with sides nearly 20 degrees in length and with a base of over 30 degrees. This system of stars consists of two stars ζ^1 and ζ^2 *Reticuli*, forming the apex of the triangle, and scarcely as bright as the fifth magnitude; ζ *Toucani*, a fourth magnitude star at the southern base angle, and ϵ. *Eridani*, a star of between the fourth and fifth magnitude, at the northern base angle. All four stars are invisible from England. Besides the apparent motion in Right Ascension and the North Polar Distance, which is possessed by all stars, astronomers have long recognized the fact that many stars possess a real independent motion in space, which though much smaller than their apparent motion, is too large for its existence to remain in doubt. In general this proper motion, as it is called, amounts to only a small fraction of a second of arc per annum; but in some few cases it amounts to considerably over a second of arc, or even to over two or three seconds of arc.

In forming the Great Catalogue of Southern Stars, which has been the main work at the Royal Observatory at the Cape of Good Hope, whilst under his direction, Mr. Stone was led to examine all the cases of supposed great proper motion in the Southern Stars of the British Association Catalogue. In the greater number of cases they were found to arise from defective observations, but in some few cases they were confirmed.

The most noteworthy instances were the group to which Mr. Stone has directed attention. From a careful consideration of each case, Mr. Stone arrived at the following conclusions:

That the four stars of the group under consideration have proper motions much larger than the average proper motions of stars.

That the stars have a common proper motion of more than a second of arc.

That each star of the group is moving away from every other star of the group, by quantities which are small compared with the common proper motion of the group.

That, roughly speaking, the velocities of separation are larger, the greater the present angular separation of the stars.

From these conclusions it seems probable that all these stars are slowly moving away from one common point, so that many years back they were all very much closer to one another, and may have formed part of one common star system.

With the present rate of motion of separation it must have taken these stars over three million years to have moved to their present positions from a point where they would have been close together.

Mr. Stone remarks that it appears to him that such a system of stars like a^1 and a^2 *Centauri*, which consist of two binary stars moving round each other, and with a large common proper motion, having by reason of that large common proper motion been brought sufficiently near to another binary double star to disturb the orbital motion of each, and change the motion of each from closed to open orbits. The whole question opened by Mr. Stone is one of the highest interest, and deserves still further investigation, when the proper time arrives.

THE NEBULA IN THE PLEIADES.

Some twenty years ago, Temple, whilst at Venice, discovered, with a four inch telescope, a fine bright nebula close to the bright star *Merope* in the *Pleiades*. It was elliptical in form, and covered an area of nearly a fifth of a square degree. Temple showed it to Valz and other astronomers, and it was seen by Peters with the eight inch equatorial of the Altona Observatory.

Subsequently it was looked for by other observers, either without success, or else seen as a very faint, indistinct object. Even Temple, though it is true with another instrument and in another locality, describes it as being far less distinct than when first seen. Subsequently, when observing near Florence with larger instruments, Temple saw the nebula as large and as bright as ever. Prof. Schiaperelli of Milan also observed it with the fine refractor at Milan, and describes it as bright and distinct, and completely surrounding the star *Merope* whilst outlaying portions seemed to extend as far as Electra. Schiaperelli remarks, it is singular that so many persons should have examined the Pleiades without paying attention to this great nebula, which, nevertheless, is so evident an object on a clear sky. Maxwell Hall, in Jamaica, also found the nebula very bright with a four inch telescope, and shows it as nearly half a square degree in area. Several astronomers came to the conclusion that the nebula was variable. Others even doubted its real existence, and were inclined to ascribe its supposed observation to the effects of atmospheric action. Of late it has been drawn by several observers, so that its real existence cannot be questioned. During this year it has been looked for by Mr. Common with the great 37-inch reflector at Ealing. The nebula was seen as a distinct object of considerable extent, but beyond it, and right within the *Pleiades*, were discovered two others, both long elliptical nebulas of tolerable well defined form. There seems reason to believe, therefor, that the entire background of the *Pleiades* is nebulous.

Dr. J. Lawrence Smith, of Louisville, Ky., has made a personal investigation of the great meteorite which fell in Emmett County in 1879, having visited the spot for the occasion. An interesting report may be seen in the *American Journal of Science*. The external appearance was that of a mass, rough and knotted like mulberry calculi, with rounded protuberances projecting from the surface. The larger portions were of a gray color, with a green mineral irregularly disseminated through it. The total weight of the portions found amounted to 307 pounds. The stoney part of this meteorite consisted essentially of bronzite and olivine, the three essential constituents being silica, ferrous oxides and magnesia. An analysis showed, that in composition the meteorite contained nothing that was peculiar. Its position, however, among meteorites is unique, on account of the phenomena accompanying its fall, especially the great depth to which it penetrated beneath the surface, and also because of its physical characters and the manner of association of its mineral constituents.

NATURAL HISTORY.

The Eggs of Eels.—We direct attention to an alleged discovery of eggs in eels, and also to the fact that both sexes had been observed nearly two hundred years ago. The following extracts are made from the Proceedings of the Royal Society about the year 1690:

"Until about twelve months since, it was currently believed that eggs had never been seen in eels, and it was considered quite an interesting discovery when a New England fisherman then discovered them in situ, and also observed specimens of eels both of the male and female sex.

"Thus a vexed point which had been discussed for two hundred years, was settled satisfactorily, when, as I understand, Professor Packard confirmed the fisherman's discovery.

"Recently, while looking over some papers read before the Royal Society of England, dating very far back, I found that a Mr. Benjamin Allen about the year 1690, read a paper before the society, claiming to have examined two eels, and 'found one with egg,' and another with 'fixed young ones, fastened to very small placentæ each, which was fixed to the intestine.' 'The eggs were on the outside of the intestine.' He also said, 'the parts distinguishing the sex are discoverable; those of the male affix to the extremity of the kidney; the female had a slender gland transversely lying near the bowel.'

"A discussion followed, and a Mr. Dale raised a doubt on account of Mr. Allen's anatomical details being inconsistent with nature, and from the fact of Leuwenhoek finding a uterus in all eels he examined, and also 'masculine seed,' from whence he conjectured they were Hermaphrodite.

"He, however, so far confirmed Mr. Allen on one point, as to state that one Walter Chetwynd, Esq., had in the month of May, 'found them to be viviparous, by cutting open the red fundaments of the females, from whence the young eels would issue forth alive.'

"No other member is reported as having spoken on the subject, and so the matter rested."

THE MODE OF SUCKLING OF THE ELEPHANT CALF.—In some of the accounts recently published of the birth of an elephant in a menagerie in America it is stated that up to this time naturalists had always believed that the elephant calf obtained its mother's milk by means of its trunk, and not directly by the mouth.

Whether this be the case or not, Aristotle was certainly an exception, as the following passage from the twenty-seventh chapter of the sixth book of his "Historia Animalium" (Ed. Bekker, Oxford, 1837) clearly proves—"Ὁ *δὲ σκύμνος, ὅταν γένηται, θηλάζει τῷ στόματι, οὐ τῷ μυκτῆρι, καὶ βαδίζει και βλέπει εὐθὺς γεννηθείς*.—"And the calf, when it is born, sucks with its mouth and not with its trunk; and it both walks and sees as soon as it is born"— (Nature.) J. C. G.

AT a recent meeting of the Buffalo Microscopical Club Mr. Jas. W. Ward exhibited a piece of glass which had been over a picture on one of the walls of his residence. It was covered with a very peculiar and interesting species of fungus, and withstood the action of soap and water in attempting to remove it. He attributed the growth to the exhalations of the breath of persons who had been in the room, and since noticing this fungus on the glass had examined several of a similar nature in other rooms and found them alike. Mr. Ward's observations brought forth an interesting debate, relative to the observations of the different members of the Club on similar growths. Dr. Howe thought it similar to the fungus which attacks the body of the *Musca domestica* (house fly). These are contagious, and can be given by one fly to another. Dr. Barrett likened it to the fungi which permeates the walls of hospitals and other public buildings. President Kellicott, since the matter had been brought to his notice, had examined the windows of the Central School building, and the City and County Hall, and found fungi on them, although not to such an extent as on the glass Mr. Ward exhibited.

Since the publication of Mr. Ward's notes, a Mr. Thomas Garfield has written to the *Scientific American* attributing the so-called fungus to a stain, or rust, which is often observed by glass makers on glass, caused by an excess of soda or potash, which produces an efflorescence. Mr. Ward, however, re-affirms that the patches are fungi, and he is satisfied of their vegetable and superficial nature.

MICROSCOPY.

The Hayden Trial Evidence.—Dr. Treadwell writes to the "*American Monthly Microscopical Journal*" disclaiming the assertions regarding the possibility of identifying human blood, which had been attributed to him. It was charged that Dr. Tredwell claimed, after measuring only four corpuscles (having accidentally lost the others), that ranged from $\frac{1}{3357}$ " to $\frac{1}{3366}$" in diameter, to have asserted: "I am quite positive that these *were human blood corpuscles*, and that they did not belong to the pig, sheep, goat, horse or cat." Dr. Tredwell now says, "I gave no opinion whatever as to any blood being human blood, except in distinction from the blood of some animal or animals named, and I defy any person to show that I have ever expressed such an opinion in any of the numerous cases in which I have testified."

On the half shell.—Mr. K. M. Cunningham suggests a quick way of getting marine diatomaceæ: by taking a peck of fresh oysters and brushing the back of each into a basin of water, this process will give Pleurosigmæ and Coscinodisci in abundance.

Thin glass covers.—A microscopist has taken the trouble to measure the thin glass covers purchased at a first class house, and found that in two ounces but one third was correct in their thickness $\frac{1}{150}$ to $\frac{1}{200}$ of an inch, two thirds belonging to a cheaper grade. Only one sixty-eighth were $\frac{1}{200}$ of an inch in thickness, the majority being only fit for opaque objects.

Infection from Mosquitos.—The discovery that mosquitos carry filaria in their probosces, and infect the human subject with that much dreaded worm parasite, has attracted considerable attention among the English Microscopists. The matter has been brought before the Quekett Microscopical Club, by Dr. Cobbold, the President, who is one of the highest authorities on this subject. Particulars of various cases were given in which it was proved that those suffering from filaria had received the contagion from mosquitos, and mosquitos themselves infected with filaria were shown.

Filaria are very minute worm-like parasites, which on entering the human body, breed until they increase to countless numbers. By recent advices we learn they have the power of entering and leaving the blood at pleasure; they usually invade the circulation about seven o'clock in the evening, and increase until about midnight, after which time they retire to other parts of the system.

Trichinæ in Fish.—It is again asserted that trichinæ have been found in fish, this time at Ostend, in Belgium. This is against previous experience, but as it is stated the worms were found in the flesh, it appears more probable that the statement may be correct.

Curious fungous deposit.—Dr. P. C. Jensen gives a drawing in "*New Remedies*" of a peculiar organized deposit, existing in a number of specimens of Acid Phosphoric. Dil., of commercial grades. Under a power of 75 diameters its appearance is that of a fibrous network very analogous in appearance to the Tela Contexta, as found in the mosses, anastomosing and exhibiting very well defined oblong muriform cells placed end to end. In the interstices of its central ramification are seen small bodies resembling nuclei. These nuclei are nearly double the size of the diverging fibres constituting the mass of the deposit. The color of the deposit is of a grayish white, with diffusive and elastic properties.

ELECTRICITY.

An interesting experiment, which seems to have a bearing on the action of Edison's friction telephone, has been recently described by Herr Koch. When a plate of platinum or palladium is polarized by means of an electric current, the friction of these metals against a plate of moistened glass increases immediately. To measure the friction, Herr Koch uses the metal in the form of a hemispherical button, resting on the bottom of a glass cup, filled with pure or acidulated water. The button serves as pivot to a magnetic needle, which oscillates under the action of the earth; the decrease of the oscillations measures the friction of the pivot. Polarization is produced by the current of the Daniell element, one pole of which communicates with the metallic button, while the other terminates with a platinum wire entering the water of the cup. The polarization by hydrogen produces no effect, but polarization with the pole oxygenated is found very efficacious. The friction was increased, through this polarization, in the ratio of 2 to 3, and sometimes in that of 2 to 4. This increase of friction appears immediately the circuit is closed, and disappears immediately when the current is reversed; but it disappears slowly, like the polarization itself, when the circuit is merely opened. It increases with the electromotive force of the polarization by oxygen. Palladium behaves like platinum. Gold (18 carat) gave no effect.

M. Desprez has lately attacked the problem of transmitting, by means of an electric current, the motion of a motor A to a receiver at some distance B, as a rigid axis between the two would do, so that the angular velocity of B should be always equal in amount and sign to that of A. (The particular case was that of getting within a railway carriage a rotation identical with that of the motor wheels of the locomotive.) On the shaft of the transmitter A are fixed two commutators, each of which reverses the current that traverses it twice each turn; but the positions of the shaft corresponding to these inversions do not coincide; they follow each other at intervals of a quarter of a turn. The receiver consists of a permanent magnet or electro-magnet, between the branches of which are two straight electro-magnets, capable of rotating round an axis which coincides with that of the magnet. The currents sent through these electro-magnets from the shaft A produce the desired effect. This apparatus (it is noted) effects the transmission of work of a motor from one point to another *with conservation of the angular velocity* (which has not been realized in any electric motor hitherto used), the latter varying from 0 to 2,400 turns per minute. The alternating currents required may be generated by a magneto-electric machine. Again, any motion may be considered as the resultant of two movements of rotation; hence this apparatus, with a simple mechanism added, would serve for transmission of a motion of drawing, or writing.

The steadiness of the incandescent light over that of the arc has long been understood, but hitherto the cost of the one has been so great that practically it was out of the question for general use. This will account for the little progress made by the Werdermann light. The cost is due principally to the consumption of carbon. Again, it is well known that the consumption of carbon, in an atmosphere containing no oxygen, or in a vacuum, is reduced to a minimum. Many inventors have tried to make lamps to retain a perfect vacuum, but have failed. It is easy, however, to make a water-tight joint, and by surrounding this with water Mr. Brougham has solved one of the problems of the incandescent lamp. The oxygen originally in the lamp globe is quickly exhausted, and then the atmosphere consists of gases which do not combine with carbon, and the result is very slow combustion or disintegration. The water-tight joints having been obtained in the manner above indicated, the globe is partially filled with water, so that when placed over the lamp globe, the water is well over the cap. This water globe is fastened by means of clamps and screws. The inventor states that while the carbon burns away at the rate of six inches per hour in the open air, it burns only one-eighth of an inch per hour when in the water-covered globe. This shows an enormous saving in the cost of carbon, and if it can be shown that the saving thus obtained is greater than the cost of the extra power absorbed by the incandescent lamp over that of the arc, a decided step will have been made towards furnishing a light that can without difficulty be applied to ordinary sized rooms. We have seen this lamp, and can testify as to its steady light.

So long as the liquid in the vessel is above the cap of the lamp, no atmospheric air can enter the lamp globe, and at the same time the heat from the lamp is carried off or dispersed and the light diffused. Provision may be made for the removal and replenishing of the liquid in or for causing it to circulate, but we are of the opinion that the ground-glass globe will prove more satisfactory as it is than any addition to the apparatus can make it. We made inquiries as to the liability of the copper wedge to melt, but its size and its connection with so large and such good conductors removes all tendency in this direction. — *Electrician.*

A simple method of perforating glass with the electric spark is described by M. Fages in a recent number of *La Nature*. The apparatus required consists (1) of a rectangular plate of ebonite, its size, for a coil giving 12 ctm. sparks, about 18 ctm. by 12; (2) of a brass wire passing under the plate and having its pointed end bent up and penetrating through the plate—not farther. This wire is connected with one of the poles of the coil. A few drops of olive oil are placed on the ebonite plate about the point, and the piece of glass to be perforated is superposed, care being taken not to imprison any bubbles of air. The olive oil perfectly accomplishes the object of insulating the wire. One has then only to bring down a wire from the outer pole of the coil, on the piece of glass, above the point of the lower wire, and pass the spark. By displacing the glass laterally for successive sparks, it is easy to make a close series of holes in a few seconds.

A new form of electric lamp has been invented by Mr. Charles Stewart, M. A. It consists of a number of square carbon rods placed radially upon a disc of wood, or metal, in such a manner that the inner ends of the carbon rods form a complete circle. There is a circular opening in the wooden disc through which the electric light is seen from underneath. The carbons which are all forced toward the centre by a uniform pressure, move forward as they are consumed, and together form the positive electrode of the lamp. The negative electrode consists of a covered hemispherical cup of copper which before the current enters the lamp, rests upon the ring formed by the carbons. On the current entering the lamp an electro-magnet raises the metal electrode, and the electric arc is then formed between the circle of carbon and the metal electrode. There is a flow of water through the latter to keep it cool. The inventor claims for his lamp the following advantages. (1). It is automatic in its action. (2). Burns for a considerable period. (3). Throws no shadows. (4). Simple and inexpensive in structure. (5). The intensity of the light may be increased if desired.

THE TELEGRAPH AND EARTHQUAKES.—A recent letter from Mr. W. A. Goodyear, now director of the governmental mining and geological survey of San Salvador, states that more than 600 shocks of earthquakes were felt there during the last ten days of 1879. They were heaviest about Lake Ilopango, where a shock occurred on the 23rd of December, which broke the telegraph wire asunder and "made the ground on which we stood a perfect network of cracks, opened new springs of water, increased the rivulets in the vicinity to ten times their usual volume, muddied the waters of the lake in many places, and rolled hundreds of thousands of tons of rocks down the steep hills in the form of landslides." As a sequal to these earthquakes, came the irruption of a volcano in the middle of Lake Ilopango on the night of January 20th to 21st. The volcanic island resulting now measures over five acres in extent, and shoots up a column of steam into the air over 1000 feet in height. This is the first instance we have heard of earthquakes interrupting land telegraph lines, though there are cases on record of their interrupting cables.

Notes and Queries.

[1.] I am studying the character and extent of a substance called "Tuckahoe, or Indian Bread," for its Ethnological interest. I find that my knowledge of Botany is not sufficient, and desire reliable information upon the following points:

What is the nature of its growth and production?
What is its geographical distribution?
Its former use and preparation?
In what kind of soil is it found?
What authors have mentioned it?
By what botanical names is it known?
Has it any medicinal properties?

J. H. G.

GENERAL NOTES.

FORMATION OF VINEGAR BY BACTERIA.—E. Wurm has investigated this matter, and his results prove, without doubt, that an active formation of vinegar from alcohol is obtained by means of Myccderma aceti (Bacterium mycoderma—Cohn), thus supporting Pasteur's view.

ORGANISMS IN BEET SAP.—The bodies known as "frog-spawn," which make their appearance after a time in the sap of the beet root, prove, on microscopic examination to be a species of bacterium, called by L. Cienkowski, Ascoccus Bilrothii.

PTYALIN AND DIASTASE.—T. Defresne has found that ptyalin converts starch into sugar, in the presence of impure gastric juice, as rapidly as it does in the mouth. Its action is, however, suspended by pure gastric juice; but on passing into the duodenum the ptyalin again becomes active. Diastase, on the other hand, is completely deprived of its power of converting starch into sugar by hydrochloric acid or by pure gastric juice. (Compt. Rend., 89, 1070.)

ABNORMAL COMPOSITION OF MILK.—According to C. Marchaud (Bied. Centr., 1872, pp, 769–770), the usual composition of human milk is as follows: butter, 36.8; lactose, 71.1; proteïn 17; salts, 2.04, and water, 873 parts per thousand. When the amount of butter rises to above 52 parts, the milk is injurious to the child. The quantity of proteïn, which is much less than in cow's milk, cannot be exceeded without ill effects.

NUTRITIVE VALUE OF GRASS AT VARIOUS STAGES OF GROWTH.—E. von Wolff and others (Bied. Centr., 1879, pp. 736–744) cut grass three times in the early summer, in the years 1874 and 1877; the first cutting took place about the middle of May, the second at the beginning and the third at the end of June. The second cutting appeared to give the best results in the case of animals experimented upon, namely sheep and horses; and, as a rule, it was found that more nitrogenous matter was excreted by the latter than by the former.

ANALYSIS OF TWO ANCIENT SAMPLES OF BUTTER.—G. W. Wigner and A. Church have examined a sample of Irish bog butter, which cannot be traced with any certainty to a particular locality. There is no doubt, however, that it is a perfectly authentic specimen, probably 1000 years old. The following results were obtained: volatile fatty acids, calculated as butyric, 6 per cent; soluble fatty acids, not volatile, 42 per cent; insoluble fixed fatty acids, 99.48 per cent; glycerol, minute traces. The insoluble fatty acids contained 9 per cent. oleic acid, and 91.0 per cent stearic and palmitic acids.

The other sample of butter, which is much older, was taken some time ago from an Egyptian tomb. It dates from about 400 or 600 years before Christ. It was contained in a small alabaster vase, and had apparently been poured in while in a melting state. In appearance, color, smell and taste, it corresponds closely with a sample of slightly rancid butter. Analysis shows that the sample has not undergone any notable decomposition.

CHLORIDE OF PLATINUM.—Dissolve the metal in hydrochloric acid, 5 parts; and nitric acid 3 parts—a florence flask is convenient for this purpose. When all the metal is dissolved transfer the solution to a porcelain evaporating dish, and apply heat until nearly the whole of the acid is expelled. Dissolved in water or in ether chloride of platinum is useful for imparting to brass articles a steel like appearance.

THE EFFECT OF CARBONIC ACID IN THE AIR UPON CROPS.—According to M. Marie-Davy, (Compt. rend. 90, pp. 32-35), an examination of the determinations of the amount of carbonic anhydride in the air, which have been made daily during the last four years at Montsouris, seems to show that the best crops have been produced in those years when the amount of carbonic anhydride has been below the average. The carbonic anhydride varies inversely with clearness of the sky, and is influenced by the oscillations of the great equatorial atmospheric currents.

RESPIRATIVE POWER OF MARSH AND WATER PLANTS.—It is a well-known fact that these plants are able to thrive in media which contain little or no oxygen. They are all very poor in nitrogen, and E. Freyberg has shown by a number of experiments, that this latter property accounts for the former. His investigations prove that the respirative power of plants varies with the amount of nitrogen they consume, and this, taken in conjunction with the fact that water-plants contain large air chambers which do not often need refilling, accounts for their being able to exist in media which contain very little oxygen.

A RAILWAY BREAK, which is instantaneously applied and continuous in its action, and which the inventor proposes to render automatic, is described by M. Hospitalier in *La Nature*. It is worked by means of two of the secondary batteries of M. Planté, each of these being charged by three Daniell cells. The action of the apparatus is dependent upon the adhesion of an electro-magnet to the axle of the wheels, by means of which two chains attached to levers carrying friction blocks, are wound upon a drum.

ARTIFICIAL DIAMONDS.—In regard to the successful work of Mr. Hannay, of Glasgow, in producing perfect artificial diamonds, it may be well to bear in mind the similar investigation carried on by Despretz, the noted French chemist. Some authorities allege that the results obtained by Despretz were in advance of those reached by Mr. Hannay, yet the former, at the conclusion of five years of labor, made the frank acknowledgment that he had not found the diamond proper, although he had obtained crystals of pure carbon possessing all the characteristics of the coveted prize.

CYANIDE OF POTASSIUM.—There are many substances which are difficult to procure, whereas the materials of which they are composed are within the reach of everybody. To make Cyanide of Potassium, use the following formula:

Yellow prussiate of potash	8 parts.
Carbonate of potash	4 parts.

Reduce the prussiate of potash to a coarse powder, and dry upon an open plate over a slow fire; next dry the carbonate of potash thoroughly, when both substances are to be intimately mixed. Put the mixture in a crucible or deep iron ladle, and place in a clear burnt coke fire. When fusion takes place, stir occasionally with an iron rod. When the mass is thoroughly fused allow it to continue in that state for at least a quarter of an hour. If on dipping the iron rod into the melted mass the compound appears *white* on cooling, the ladle may be withdrawn from the fire, allowed to rest for a few minutes, when the cyanide which is formed, must be poured in patches on an iron slab or flagstone, care being taken not to allow the dross, which is chiefly iron, to pass out with the clear fused cyanide. The "dross" should be shaken out separately, and when cold washed with water to dissolve out the adherent cyanide, after which the washing water may be filtered and used as a solution of cyanide when required. Keep the cyanide in a wide mouth bottle well corked, and labelled.

SATURDAY JULY 10, 1880.

UNIFORM TIME.

BY PROFESSOR ORMOND STONE.

It would be a great convenience to the traveling public if all the railroads of the country employed a uniform standard of time. The inconvenience of the present system is so manifest, that it is strange that a united effort has not been made before this to correct it. In so small a country as England the question is a very simple one, but in a country like ours extending over nearly sixty degrees of longitude, or four hours of time, the problem assumes a different aspect owing to the tendency everywhere to employ local time.

In selecting a standard meridian the mind naturally fixes upon Washington as the capitol of the nation and the seat of the largest and best equipped observatory. This meridian passes through the States of New York, Pennsylvania, Maryland, Virginia and North Carolina, and it is hard to imagine what good reason there is that the railroads passing through those States should not run by Washington time. The meridian of Washington is nearly midway between the termini of the three great trunk lines of New York and Pennsylvania. Nevertheless the actual standard employed by each of those roads is clear at one end of the route. Even the Baltimore and Ohio runs by Baltimore instead of Washington time. The meridian thirty minutes west of Washington passes through Michigan, Ohio, Kentucky, Tennessee, Georgia and Florida, and might be adopted as the standard for those States. In four of them it passes very near the capitol or the chief city of the State. In the same manner the roads of Minnesota, Iowa, Missouri, Arkansas and Louisiana might refer their time to a meridian an hour West of Washington; and so on, for the States and Territories lying beyond.

Such a system offers many advantages. The Western Union Telegraph Company transmits Washington time signals each day at noon to nearly all the railroad towns in a large portion of the Union. These signals might be utilized independently of the local time, and the great confusion which now exists would be done away with without greatly violating the preconceived notions of the general public. True noon would still occur within a few minutes of twelve o'clock by the standard time. In addition to the Washington Observatory, two others—the Cincinnati and the Morrison Observatories—have already adopted the standard of time which would accord with this plan, and it is to be hoped that others will follow their example.

WATER SUPPLY OF CITIES.

DR. H. C. H. HEROLD.

The condition of the water supply of cities is now receiving increased attention from sanitary authorities and the medical profession in all countries, especially in England, where the subject has been fully investigated under government authority.

In the series of reports made to the Privy Council of England, Mr. Simon says, "That while it is impossible to make even a rough estimate of the number of persons annually sacrificed by impure water, taking the cases of enteric fever alone, no less than 6,879 deaths occurred recently in one year in England and Wales." In the admirable fifth report, Mr. Simon presents an abstract of no less than one hundred and sixty-four epidemics of typhoid fever, investigated by the department during four years, in all which cases excremental pollution of air or water—generally both—were found to be the the cause of the sickness.

It is not my present intention to discuss this question as a whole, but to offer a few facts which will be important to those who rely on wells for their supply of water.

A few weeks since, a large firm whose place of business occupies an entire block in what is called the down-town portion of the city of New York, finding that the use of the water drawn from their well entailed painful results to those who drank it, directed me to make a chemical analysis of a sample of the water taken from the well in question.

The water was clear and sparkling, but had a perceptible bitter taste. The result of the analysis proved to be as follows:

	Grains in U. S. Gallon.
Total Residue after evaporation	26.195
Organic or Volatile matter	5.372
Soda (Na O)	3.596
Chlorine (Cl)	5.312
Magnesia (Mg O)	2.635
Sulpharic Acid (SO_3)	4.247
Lime (Ca O)	4.044
Carbonic Acid (CO_2)	3.664
Silicic Acid	1.447

The above ingredients are present in the following combinations:

Chloride of Sodium (Na Cl)	6.846
Chloride of Magnesium (Mg Cl_2)	1.513
Sulphate of Lime, (Ca O, SO_3)	7.221
Bi-Carbonate of Lime, (Ca O,) ($2CO_2$)	2.754
Carbonate of Magnesia, 5(Mg O) 4(CO_2) 6(HO)	4.854

I need not add, that when this report was made, the use of the well was at once discontinued, for it was palpably unfit for drinking purposes, the large per centage of Chloride of Sodium (nearly 7 grains to the gallon) was decisive of sewage or drainage contamination being present, one grain to the gallon of that substance being considered by the best authorities as the outside limit, for water fit for domestic use.—The large amount of other inorganic impurities will also be noticed by professional readers, for such a large amount of solid residue, would make it a very bad water even for boilers, on account of the Lime, Magnesia and Silica being deposited as a very hard incrustation. Lastly, the analysis shows that the organic matter is largely in excess of what it should be—5.372 grains to the U. S. gallon.

For the purpose of comparison, I offer the result of a chemical analysis of the much abused Croton Water of New York City, made by Professor C. F. Chandler about three years ago, which is as follows:—

	Grains in U. S. Gallon.
Soda	0.326
Potassa	0.097
Lime	0.988
Magnesia	0.524
Chlorine	0.243
Sulphuric Acid	0.322
Silica	0.621
Carbonic Acid	2.604
Organic and Volatile Matter	0.670

VISUAL TELEGRAPHY.

For many years past scientific men have been familiar with the fact, that the reflected images of objects could be reproduced at a distance by the aid of electricity, but recently the matter has been again taken up, and is now being prominently brought before the public under headings of "seeing by telegraph."—

The general principle involved may be gathered from the description of the "*Diaphote*," an instrument introduced by Dr. H. E. Licks of Bethlehem, Penn., "for seeing by telegraph." He calls it by this name "from two Greek words, *dia*, through, and *phos*, light." He lately read a paper in Reading, and exhibited his instrument. This consists of a receiving mirror, the wires, a battery, and a reproducing speculum. The receiving mirror is an amalgam of selenium and iodide of silver; the reproducing speculum is a compound of selenium and chromium. The wires are numerous, as it is necessary for distinctness that a wire should be required to affect but a very small space. The instrument exhibited had a mirror six inches by four, composed of seventy-two small plates to each of which a wire was attached, the whole being wrapped by a fine insulated covering. These wires run to a common galvanic battery and thus connect with the reproducing plate. When the circuit is closed, the rays of light are conducted through an ordinary camera, and the accompanying heat produces chemical changes in the the amalgam of the mirror, which, modifying the electric current, cause similar changes in the reproducing speculum. In the experiments at the close of the explanatory lecture, an instrument was taken to a lower room of the building and operated from there to the stage in the presence of the audience. Before the mirror in the lower room the committee held in succession an apple, a pen knife, and a trade dollar, which were distinct on the platform above. The date on the trade dollar, thrown on an enlarged screen, was plainly visible, as well as the goddess of liberty. A watch was next used, and the audience could see the movement of the hands. An ink bottle, a flower, parts of a theatre hand-bill, were also shown, and when the head of a live kitten was exhibited, there was great applause, and the inventor warmly congratulated on his success. The opinions entertained of its practical value are very high—it being possible for a signal officer on a railroad to see hundreds of miles of track at the same instant."

We are informed by a gentlemen residing near New York, that during a visit to France a few years ago, his attention was called to the successful attempt of the police authorities aided by a Scientest, to reproduce at a distant city by telegraph the features of a criminal who was fleeing from justice. In this case the means employed were perfectly successful, and the results obtained identical to those claimed in the "*Diaphote.*"

There are other methods by which "*seeing by telegraph*" can be accomplished. Professor Graham Bell has deposited with the Smithsonian Institute a sealed description of an instrument he has invented, which has caused Messrs. Ayrton & Perry of England, who have been working on the same problem, to offer the following statement, which indicates the means they employ:

"While we are still quite in ignorance of the nature of this invention, it may be well to intimate that complete means for seeing by telegraphy have been known for some time by scientific men. The following plan has often been discussed by us with our friends, and no doubt has suggested itself to others acquainted with the physicial discoveries of the last four years. It has not been carried out because of its elaborate nature and on account of its expensive character. Nor should we recommend its being carried out.

Our transmitter at A—that is, the apparatus for receiving the light impressions and transmitting them electrically—consisted of a large surface made up of very small separate squares of selenium. One end of each piece was connected by an insulated wire to the distant place, and the other end of each piece with the ground, in accordance with the plan commonly employed with telegraph instruments. The object whose image was to be sent by telegraph was illuminated very strongly, and by means of a lens a very large image was thrown on the surface of the above transmitter. Now, it is well known if each little piece of selenium forms part of a circuit in which there is a constant electromotive force, say of a voltaic battery, the current passing through each piece will depend on its illumination. Hence, the strength of the electric current in each telegraph line will depend on the illumination of its extremity. Our receiver at the other end, B, was, in our original plan, a collection of magnetic needles, the movements of each of which (as in the ordinary needle telegraph) were controlled by the electric current passing through the particular telegraph wire with which it was in connection. Each magnet by its movement closed or opened an aperture through which light passed to illuminate the back of a sheet of frosted glass. There were, of course, as many of the illuminated squares at B as of selenium squares at A, and it is quite evident that since the illumination of each receiving square depends on the strength of the current in its circuit, and this current again depends on the illumination of the selenium at the other end of the wire, the image of a distant object might in this way be transmitted as a mosaic by electricity.

A more promising arrangement, suggested by Professor Kerr's experiments, consisted in having each square at B made of silvered soft iron, and forming the end of the core of a little electro-magnet, round which passed the current, coming from the corresponding selenium square at the other end. We proposed that the surface formed by these squares at B should be illuminated by a great beam of light, polarized by reflection from glass, and received again by an analyzer. It is then evident that since the intensity of the analyzed light depends on the rotation of the plane of polarization, by each little square of iron, and this depends on the strength of the current, and that again on the illumination of the selenium, we have another

method of receiving at B the illumination of the little squares at A."

Even this plan appears to have been anticipated in one sense two years ago, by Mr. J. E. H. Gordon of London, who says:

"I used an electromagnet consisting of an iron bar 2 feet 4 inches long and 2½ inches in diameter, surrounded by 70 lbs. of wire, and excited by ten Grove cells.

The total *double* rotation produced, not by slightly altering the resistance, but by reversing the current, was never more than 26′ (twenty-six minutes of arc).

To see this at all with a very delicate Jellett analyzer, it was necessary for the observer to increase the sensitiveness of his eye by sitting in total darkness for some ten minutes before each observation.

Your readers can judge what chance of obtaining visible changes of illumination there would be with 'little' magnets and mere variations in a current not powerful enough to fuse a selenium resistance."

Lastly we may offer an apparatus arranged by Mr. Middleton of Cambridge, England, who gives the following account of it:—

"A lens is used to throw on a plane or suitably curved receiving plate (inclosed in a camera) the image of any object. The receiving plate of the camera is composed of thermopile elements, ground to a smooth surface, and having their posterior faces put in electrical communication by a system of wires, with a somewhat similarly constructed plate. The heating, &c., effect of the image on the first plate generates currents of electricity, which flow through the wire system, and on reaching the second thermopile plate are reconverted into heat, &c., according to the law discovered by Peltier, the amount of heat, &c., being directly proportional to the amount of electricity.

Moreover, according to the manner in which the elements of the plate are arranged with respect to each other, we can get a 'positive' or 'negative' (to use the ordinary phraseology of photography) picture on the second receiving plate, since the Peltier effect here holds, and the copy of a picture depends solely on establishing a constant ratio in the radiant heat and light which corresponding points of the picture and copy send to the eye.

Furthermore, these images can be either viewed directly or by reflected light (after the fashion of the the Japanese mirrors and projection on a screen), or by suitable apparatus they can be retained as a photograph, a thermograph, or chemicograph, the details of which will be found in the paper alluded to, and of which an abstract will, I believe, soon appear in the Proceedings of the Cambridge Philosophical Society. Also, I touched upon the method of attacking the problem of photographing in colors, and in conclusion pointed out a striking anology between the camera of the instrument and that of the human eye; the thermo-electric elements of the instrument and the rods and the cones of the eye; the conducting system of insulated wires emanating from the plate of the instrument and the optic nerve (or bundle of conducting fibres of the eye)—supposing that as the electric currents in the instruments effected a registration on the sensitive paper, so in the eye the nerve currents of the optic nerve probably leave some brain trace on the mind."

It will thus be seen that while "seeing by telegraph" is not by any means a new invention, the principle involved is one full of interest, and as yet but partially developed; in this field of research ample scope will be found for those working in this direction and valuable results may be anticipated.

THE COMING OF AGE OF THE ORIGIN OF SPECIES.[1]

Many of you will be familiar with the aspect of this small green-covered book. It is a copy of the first edition of the "Origin of Species," and bears the date of its production—the first of October, 1859. Only a few months, therefore, are needed to complete the full tale of twenty-one years since its birthday.

Those whose memories carry them back to this time will remember that the infant was remarkably lively, and that a great number of excellent persons mistook its manifestations of a vigorous individuality for mere naughtiness; in fact there was a very pretty turmoil about its cradle. My recollections of the period are particularly vivid; for having conceived a tender affection for a child of what appeared to me to be such remarkable promise, I acted for some time in the capacity of a sort of under-nurse, and thus came in for my share of the storms which threatened even the very life of the young creature. For some years it was undoubtedly warm work, but considering how exceedingly unpleasant the apparition of the new-comer must have been to those who did not fall in love with him at first sight, I think it is to the credit of our age that the war was not fiercer, and that the more bitter and unscrupulous forms of opposition died away as soon as they did.

I speak of this period as of something past and gone, possessing merely a historical, I had almost said an antiquarian, interest. For, during the second decade of the existence of the "Origin of Species," opposition, though by no means dead, assumed a different aspect. On the part of all those who had any reason to respect themselves, it assumed a thoroughly respectful character. By this time the dullest began to perceive that the child was not likely to perish of any congenital weakness or infantile disorder, but was growing into a stalwart personage, upon whom mere goody scoldings and threatenings with the birch-rod were quite thrown away.

In fact, those who have watched the progress of science within the last ten years will bear me out to the full when I assert that there is no field of biological inquiry in which the influences of the "Origin of Species" is not traceable; the foremost men of science in every country are either avowed champions of its leading doctrines, or at any rate abstain from opposing them; a host of young and ardent investigators seek for and find inspiration and guidance in Mr. Darwin's great work; and the general doctrine of Evolution, to one side of which it gives expression, finds in the phenomena of biology a firm base of operations whence it may conduct its conquest of the whole realm of nature.

History warns us, however, that it is the customary fate of new truths to begin as heresies and to end as superstitions; and, as matters now stand, it is hardly rash to anticipate that, in another twenty years, the new generation, educated under the influences of the present day, will be in danger of accepting the main doctrines of the Origin of Species with as little reflection, and it may be with as little justification, as so many of our contemporaries, twenty years ago, rejected them.

Against any such a consummation let us all devoutly pray; for the scientific spirit is of more value than its products, and irrationally-held truths may be more harmful than reasoned errors. Now the essence of the scientific spirit is criticism. It tells us that to whatever doctrine claiming our assent, we should reply, take it if you can compel it. The struggle for existence holds as much in the

1 A Lecture delivered at the Royal Institute, Friday, March 19.

intellectual as in the physical world. A theory is a species of thinking, and its right to exist is coextensive with its power of resisting extinction by its rivals.

From this point of view it appears to me that it would be but a poor way of celebrating the Coming of Age of the Origin of Species were I merely to dwell upon the facts, undoubted and remarkable as they are, of its far-reaching influence and of the great following of ardent disciples who are occupied in spreading and developing its doctrines. Mere insanities and inanities have before now swollen to portentous size in the course of twenty years. Let us rather ask this prodigious change in opinion to justify itself; let us inquire whether anything has happened since 1859 which will explain, on rational grounds, why so many are worshipping that which they burned, and burning that which they worshipped. It is only in this way that we shall acquire the means of judging whether the movement we have witnessed is a mere eddy of fashion, or truly one with the irreversible current of intellectual progress, and, like it, safe from retrogressive reaction.

Every belief is the product of two factors: the first is the state of the mind to which the evidence in favor of that belief is presented; and the second is the logical cogency of the evidence itself. In both these respects the history of biological science during the last twenty years appears to me to afford an ample explanation of the change which has taken place; and a brief consideration of the salient events of that history will enable us to understand why, if the "Origin of Species" appeared now, it would meet with a very different reception from that which greeted it in 1859.

One-and-twenty years ago, in spite of the work commenced by Hutton, and continued with rare skill and patience by Lyell, the dominant view of the past history of the earth was catastrophic. Great and sudden physical revolutions, wholesale creations and extinctions of living beings, were the ordinary machinery of the geological epoch brought in fashion by the misapplied genius of Cuvier. It was gravely maintained and taught that the end of every geological epoch was signalized by a cataclysm, by which every living being on the globe was swept away, to be replaced by a brand-new creation when the world returned to quiescence. A scheme of nature which appeared to be modelled on the likeness of a succession of rubbers of whist, at the end of each of which the players upset the table and called for a new pack, did not seem to shock anybody.

I may be wrong, but I doubt if at the present time there is a single responsible representative of these opinions left. The progress of scientific geology has elevated the fundamental principle of uniformitarianism, that the explanation of the past is to be sought in the study of the present, into the position of an axiom; and the wild speculations of the catastrophists, to which we all listened with respect a quarter of a century ago, would hardly find a single patient hearer at the present day. No physical geologist now dreams of seeking outside the ranges of known natural causes for the explanation of anything that happened millions of years ago, any more than he would be guilty of the like absurdity in regard to current events.

The effect of this change of opinion upon biological speculation is obvious. For, if there have been no periodical general physical catastrophes, what brought about the assumed general extinctions and re-creations of life which are the corresponding biological catastrophes? And if no such interruptions of the ordinary course of nature have taken place in the organic, any more than in the inorganic world, what alternative is there to the admission of Evolution?

The doctrine of Evolution in Biology is the necessary result of the logical application of the principles of uniformitarianism to the phenomena of life. Darwin is the natural successor of Hutton and Lyell, and the "Origin of Species" the natural sequence of the "Principles of Geology."

The fundamental doctrine of the "Origin of Species," as of all forms of the theory of Evolution applied to biology, is "that the innumerable species, genera, and families of organic beings with which the world is peopled have all descended, each within its own class or group, from common parents, and have all been modified in the course of descent."[1]

[1] "Origin of Species," ed. 1, p. 457.

And, in view of the facts of geology, it follows that all living animals and plants "are the lineal descendants of those which lived long before the Silurian epoch."[1]

It is an obvious consequence of this theory of Descent with Modification, as it is sometimes called, that all plants and animals, however different they may now be, must, at one time or other, have been connected by direct or indirect intermediate gradations, and that the appearance of isolation presented by various groups of organic beings must be unreal.

No part of Mr. Darwin's work ran more directly counter to the prepossessions of naturalists twenty years ago than this. And such prepossessions were very excusable, for there was undoubtedly a great deal to be said, at that time, in favor of the fixity of species and of the existence of great breaks, which there was no obvious or probable means of filling up, between various groups of organic beings.

For various reasons, scientific and unscientific, much had been made of the hiatus between man and the rest of the higher mammalia, and it is no wonder that issue was first joined on this part of the controversy. I have no wish to revive past and happily forgotten controversies, but I must state the simple fact that the distinctions in cerebral and other characters, which were so hotly affirmed to separate man from all other animals in 1860, have all been demonstrated to be non-existent, and that the contrary doctrine is now universally accepted and taught.

But there were other cases in which the wide structual gaps asserted to exist between one group of animals and another were by no means fictitious; and, when such structual breaks were real, Mr. Darwin could account for them only by supposing that the intermediate forms which once existed had become extinct. In a remarkable passage he says:—

"We may thus account even for the distinctness of whole classes from each other—for instance of birds from all other vertebrate animals—by the belief that many animal forms of life have been utterly lost, through which the early progenitors of birds were formerly connected with the early progenitors of the other vetebrate classes."[2]

Adverse criticism made merry over such suggestions as these. Of course it was easy to get out of the difficulty by supposing extinction; but where was the slightest evidence that such intermediate forms between birds and reptiles as the hypothesis required ever existed? And then probably followed a tirade upon this terrible forsaking of the paths of "Baconian induction."

But the progress of knowledge has justified Mr. Darwin to an extent which could hardly have been anticipated. In 1862, the specimen of *Archæopteryx*, which until the last two or three years has remained unique, was discovered; and it is an animal which, in its feathers and the greater part of its organization, is a veritable bird, while, in other parts, it is as distinctly reptilian.

In 1868, I had the honour of bringing under your notice, in this theatre, the results of investigations made, up to that time, into the anatomical characters of certain ancient reptiles, which showed the nature of the modifications in virtue of which the type of the quadrupedal reptile passed into that of the bipedal bird; and abundant confirmatory evidence of the justice of the conclusions which I then laid before you has since come to light.

In 1875, the discovery of the toothed birds of the cretaceous formation in North America, by Prof. Marsh, completed the series of transitional forms between birds and reptiles, and removed Mr. Darwin's proposition that "many animal forms of life have been utterly lost, through which the early progenitors of birds were formerly connected with the early progenitors of the other vertebrate classes," from the region of hypothesis to that of demonstrable fact.

In 1859, there appeared to be a very sharp and clear hiatus between vertebrated and invertebrated animals, not only in their structure, but, what was more important, in their development. I do not think that we even yet know the precise links of connection between the two; but the investigations of Kowalewsky and others upon the develop-

[1] "Origin of Species," ed. 1, p. 458.
[2] "Origin of Species," ed. 1, p. 431.

ment of *Amphioxus* and of the *Tunicata* prove beyond a doubt that the differences which were supposed to constitute a barrier between the two are non-existent. There is no longer any difficulty in understanding how the vertebrate type may have arisen from the invertebrate, though the full proof of the manner in which the transition was actually effected may still be lacking.

Again, in 1859, there appeared to be a no less sharp separation between the two great groups of flowering and flowerless plants. It is only subsequently that the series of remarkable investigations inaugurated by Hofmeister has brought to light the extraordinary and altogether unexpected modifications of the reproductive apparatus in the *Lycopodiaceæ*, the *Rhizocarpeæ*, and the *Gymnospermeæ*, by which the ferns and the mosses are gradually connected with the Phanerogamic division of the vegetable world.

So, again, it is only since 1859 that we have acquired that wealth of knowledge of the lowest forms of life which demonstrates the futility of any attempt to separate the lowest plants from the lowest animals, and shows that the two kingdoms of living nature have a common borderland which belongs to both or to neither.

Thus it will be observed that the whole tendency of biological investigation since 1859 has been in the direction of removing the difficulties which the apparent breaks in the series created at that time; and the recognition of gradation is the first step towards the acceptance of evolution.

As another great factor in bringing about the change of opinion which has taken place among naturalists, I count the astonishing progress which has been made in the study of embryology. Twenty years ago, not only were we devoid of any accurate knowledge of the mode of development of many groups of animals and plants, but the methods of investigation were rude and imperfect. At the present time there is no important group of organic beings the development of which has not been carefully studied, and the modern methods of hardening and section-making enable the embryologist to determine the nature of the process in each case, with a degree of minuteness and accuracy which is truly astonishing to those whose memories carry them back to the beginnings of modern histology. And the results of these embryological investigations are in complete harmony with the requirements of the doctrine of evolution. The first beginnings of all the higher forms of animal life are similar, and however diverse their adult conditions, they start from a common foundation. Moreover the process of development of the animal or the plant from its primary egg or germ is a true process of evolution—a process from almost formless to more or less highly organized matter, in virtue of the properties inherent in that matter.

To those who are familiar with the process of development all *à priori* objections to the doctrine of biological evolution appear childish. Any one who has watched the gradual formation of a complicated animal from the protoplasmic mass which constitutes the essential element of a frog's or a hen's egg has had under his eyes sufficient evidence that a similar evolution of the animal world from the like foundation is, at any rate, possible.

Yet another product of investigation has largely contributed to the removal of the objections to the doctrine of Evolution current in 1859. It is the proof afforded by successive discoveries that Mr. Darwin did not overestimate the imperfection of the geological record. No more striking illustration of this is needed than a comparison of our knowledge of the mammalian fauna of the Tertiary epoch in 1859 with its present condition. M. Gaudry's researches on the fossils of Pikermi were published in 1868, those of Messrs. Leidy, Marsh, and Cope on the fossils of the Western Territories of America, have appeared almost wholly since 1870; those of M. Filhol, on the phosphorites of Quercy, in 1878. The general effect of these investigations has been to introduce us to a multitude of extinct animals, the existence of which was previously hardly suspected; just as if zoologists were to become aquainted with a country, hitherto unknown, as rich in novel forms of life, as Brazil or South Africa once were to Europeans. Indeed the fossil fauna of the Western Territories of America bids fair to exceed in interest and importance all other known Tertiary deposits put together; and yet, with the exception of the case of the American Tertiaries, these investigations have extended over very limited areas, and at Pikermi were confined to an extremely small space.

Such appear to me to be the chief events in the history of the progress of knowledge, during the last twenty years, which account for the changed feeling with which the doctrine of Evolution is at present regarded by those who have followed the advance of biological science in respect of those problems which bear indirectly upon that doctrine.

But all this remains mere secondary evidence. It may remove dissent, but it does not compel assent. Primary and direct evidence in favor of Evolution can be furnished only by palæontology. The geological record, so soon as it approaches completeness, must, when properly questioned, yield either an affirmative or negative answer; if evolution has taken place, there will its mark be left; if it has not taken place, there will lie its refutation.

What was the state of matters in 1859? Let us hear Mr. Darwin, who may be trusted always to state the case against himself as strongly as possible.

"On this doctrine of the extermination of an infinitude of connecting links between the living and extinct inhabitants of the world, and at each successive period between the extinct and still older species, why is not every geological formation charged with such links? Why does not every collection of fossil remains afford plain evidence of the gradation and mutation of the forms of life? We meet with no such evidence, and this is the most obvious and plausible of the many objections which may be urged against my theory."[1]

Nothing could have been more useful to the opposition than this characteristically candid avowal, twisted as it immediately was into an admission that the writer's views were contradicted by the facts of palæontogy. But, in fact, Mr. Darwin made no such admission. What he says in effect is, not that palæontological evidence is against him, but that it is not distinctly in his favor; and without attempting to attenuate the fact, he accounts for it by the scantiness and the imperfection of that evidence.

What is the state of the case now, when, as we have seen, the amount of our knowledge respecting the mammalia of the Tertiary epoch is increased fifty-fold, and in some directions even approaches completeness?

Simply this, that if the doctrine of Evolution has not existed palæontologists must have invented it, so irresistibly is it forced upon the mind by the study of the remains of the Tertiary mammalia which have been brought to light since 1859.

Among the fossils of Pikermi, Gaudry found the successive stages by which the ancient civets passed into the more modern hyænas; through the Tertiary deposits of Western America, Marsh tracked the successive forms by which the ancient stock of the horse has passed into its present form; and innumerable less complete indications of the mode of evolution of other groups of the higher mammalia have been obtained.

In the remarkable memoir on the Phosphorites of Quercy, to which I have referred, M. Filhol describes no fewer than seventeen varieties of the genus *Cynodictis*, which fill up all the interval between the viverine animals and the bear-like dog *Amphicyon*; nor do I know any solid ground of objection to the supposition that in this *Cynodictis-Amphicyon* group we have the stock whence all the Viveridæ, Felidæ, Hyænidæ, Canidæ, and perhaps the Procyonidæ and Ursidæ, of the present fauna have been evolved. On the contrary, there is a great deal to be said in its favor.

In the course of summing up his results, M. Filhol observes[2]:—

"During the epoch of the phosphorites, great changes took place in animal forms, and almost the same types as those which now exist became defined from one another.

Under the influence of natural conditions of which we have no exact knowledge, though traces of them are discoverable, species have been modified in a thousand ways: races have arisen which, becoming fixed, have

(*Concluded on page* 20.)

1 "Origin of Species, ed. 1, p. 463.
2 This passage was omitted in the delivery of the lecture.